

Diesel Fuel Comparison Study Workshop

December 3, 2008

California Environmental Protection Agency



Air Resources Board

Agenda

- Project Overview
 - Project Schedule
 - Staff Recommendation: Diesel Test Fuel Properties
 - CARB ULSD
 - Federal A ULSD
 - Federal B ULSD
 - Staff Recommendation: Revised Test Plan
 - Objective & Scope
 - Proposed Test Engine/Cycle Selection
 - Proposed Test Vehicle/Cycle Selection
- Future Discussion Topics
- Next Meeting

Project Schedule

- Contract reinstated on November 3, 2008
- Auto Alliance 2007 Summer Diesel Fuel Survey purchased
- Advisory panel convened December 3, 2008
- Review of fuel properties complete
- Need to purchase and ship diesel test fuel
- Need to finalize draft test plan
- Emissions Testing – scheduled to begin in March 2009
 - Coordinating schedules with Biodiesel Research Program

Diesel Test Fuel Selection

- Staff Recommendation - Propose using three test fuels:
 - Representative or 'Average' CARB ULSD
 - Representative or 'Average' Federal ULSD
 - Commercially available Federal ULSD with fuel properties that would lead to higher exhaust emissions

CARB Diesel Fuel Properties

Summer 2006 & 2007 averages and Proposed Test Fuel Ranges

Property	Average Fuel Properties ¹ Summer 2006 ²	Average Fuel Properties ³ Summer 2007 ⁴	Proposed Ranges for “Average” CARB ULSD Test Fuel
API Gravity	38.5	37.6	37.5 – 39
T50 (°F)	479	480	470 – 490
T90 (°F)	606	602	595 - 615
Aromatics (V %)	17.6	16.7	16 – 18
Cetane Number (additized)	51.3	51.8	51- 54
Sulfur (ppm)	4.4	4	<5

¹ All data represent volume weighted averages.

² Summer 2006: Refers to the period from June 1 through September 20, 2006.

³ Data average of 12 - 50 samples taken from CA refineries, volume weighted.

⁴ Summer 2007: Refers to the period from May 21 through August 16, 2007.

Federal Diesel Fuel Properties

“Alliance of Automobile Manufacturers” North American Fuel Survey”

Summary Statistics for Selected Properties from the Summer 2007 Survey

Note: Statistics based on data from 17 U.S. cities, Los Angeles data has been removed

#2 Regular Diesel S15	2007 Summer ¹		
	min	max	avg
Gravity, °API	33.0	38.9	35.5
T50 (°F)	472	548	506
T90 (°F)	576	639	607
Aromatics (V %)	19.9	40	28.2
Cetane Number	40.2	55.0	46.4
Sulfur ² (ppm)	2	17	6
¹ Samples taken in July 2007 ² Using ASTM D5453			

Federal Diesel Fuel Properties

Northrop Grumman 2007 Diesel Fuel Oils Survey, April 2008
2-D Low Sulfur On-Highway Fuel, Summer 2007

#2 Regular Diesel S15	2007 Summer ¹		
	min	max	avg
Gravity, °API	34.1	39.0	35.9
T50 (°F)	476	519	496
T90 (°F)	568	628	602
Aromatics (V %)	17.5	35.3	28.9
Cetane Number	42.0	54.4	46.5
Sulfur (ppm)	3	8	6
¹ Based on 17 samples only, Summer 2007			

Comparison of Federal Diesel Fuel Survey Data

Averages Properties of Samples Collected Summer 2007

Properties	“Alliance of Automobile Manufacturers” North American Fuel Survey Averages ¹ , Summer 2007	Northrop Grumman 2007 Diesel Fuel Oils Survey, April 2008 Averages ² , Summer 2007
Gravity, °API	35.5	35.9
T50 (°F)	506	496
T90 (°F)	607	602
Aromatics (v/v)	28.2	28.9
Cetane Number	46.4	46.5
Sulfur (ppm)	6	6

¹ Statistics are based on data from 17 U.S cities, data from Los Angeles, California has been removed from the sample

² Statistics are based on data from 17 diesel fuel oils marketed throughout the United States by 4 petroleum refining companies

Proposed Ranges for Average Federal ULSD Test Fuel Selection (Federal – A) Revised November 2008

Property	“Average” Federal ULSD Ranges (Federal – A)	“Average” CARB ULSD Ranges
API Gravity	35 - 36	38 – 39
T50 (°F)	490 – 510	470 – 490
T90 (°F)	595 – 615	595 - 615
Aromatics (v/v)	28 - 30	16 – 18
Cetane Number	44 - 47	51- 54
Sulfur (ppm)	6 - 9	<5

Proposed Ranges for Boundary Federal ULSD Test Fuel Selection (Federal – B)

Property	“Boundary” Federal ULSD Ranges (Federal – B)
API Gravity	33 - 34
T50 (°F)	≥500
T90 (°F)	>620
Aromatics (v/v)	35 - 40
Cetane Number	40 - 42
Sulfur (ppm)	<15

Revised Draft Test Plan Review

- *Assessment of the Emissions from the Use of California Air Resources Board Qualified Diesel Fuel in Comparison with Federal Diesel Fuels – Overview*

Objective & Scope

- Design & implement test program to define the emissions benefits of CARB diesel fuel versus several different Federal diesel fuel blends
 - Proposed scope:
 - Engine dyno – Test 3 (4 if 2010 engine is available) engines, two test cycles
 - Chassis dyno – 9 test vehicles, 1 test cycle, ARB HHDDT cruise, multiple test repetitions per fuel
 - Fuels – 1 ‘representative’ CARB diesel, 2 Federal diesel ‘blends’
 - Emissions measurements – THC, CO, CO₂, NO_x, NO, PM

Test Engine Selection - Engine Dynamometer Testing

- Test Engine 1 – 2006 Cummins ISM 370, 10.8 liter, EGR
 - EFN: 6CEXH0661MAT
- Test Engine 2 – 2007 DDC MBE4000, 12.8 liter
 - EFN: 7DDXH12.8DJA
 - EGR+OC+PTOX
- Test Engine 3 – 1991 DDC Series 60, 11.1 liter
 - EFN: MDD11.1FZAZ

Test Engine Selection - 2010 Compliant Engine

- Still seeking a 2010 compliant engine for inclusion in the engine dynamometer test matrix
 - Must include NOx after treatment
 - A pre-production or prototype engine would be sufficient
 - Must locate and secure an engine for testing by March 2009 for inclusion in the study

Test Cycle Selection – Engine Dynamometer

- Two test cycles selected
 - **First Cycle:** Heavy Duty Federal Test Procedure (FTP) Transient Cycle
 - **Second Cycle:** ARB Heavy Heavy-Duty Diesel Truck (HHDDT) cruise cycle
 - 2083 second cycle with 40 mph average speed
 - Translated cycle, can be used on engine or chassis dynamometers
 - Engine dyno results could be confirmed by chassis testing of in-use HDD fleet

Proposed Test Vehicle Selection - Chassis Dynamometer Testing

- Propose testing a matrix of 9 vehicles
 - Matrix should be based on CA's in-use HD on-road fleet
 - Should incorporate a range of technologies if possible
 - Engine dynamometer test results will help shape final matrix

Test Cycle Selection – Chassis Dynamometer

- ARB HHDDT cruise cycle selected
 - 12 test replicates per fuel type

Staff Recommendation: Approve the Revised Draft Test Plan

- *Assessment of the Emissions from the Use of California Air Resources Board Qualified Diesel Fuel in Comparison with Federal Diesel Fuels – Overview*

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Future Discussion Topics

- 2010 compliant engine for inclusion in the fuel comparison study
- Locate & purchase Comparison Study test fuels
- Revisions to the Test Plan
- Continued coordination with the Biodiesel research project

Next Meeting

- Tentatively scheduled for January 2009
- Visit our web site
 - <http://www.arb.ca.gov/fuels/diesel/dieselcomp/dieselcomp.htm>

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HHD Population Data

Calendar Year 2007

Model Year	Population		VMT		NOX		PM	
	(#)	(%)	(mi/day)	(%)	(t/d)	(%)	(t/d)	(%)
2007	9,037	4.2 %	2,452,385	6.8 %	16.15	2 %	0.15	0.5 %
2002 - 2006	36,930	17.3 %	10,431,370	28.8 %	145.55	18.3 %	6.24	18.5 %
1994 - 2001	92,890	43.6 %	17,447,971	48.1 %	475.79	59.9 %	13.05	38.8 %
1991 - 1993	20,018	9.4 %	2,279,696	6.3 %	65.37	8.2 %	2.92	8.7 %
1987 - 1990	27,395	12.9 %	2,388,688	6.6 %	59.42	7.5 %	6.99	20.7 %
Pre - 1987	26,584	12.5 %	1,259,343	3.5 %	31.78	4 %	4.33	12.8 %

MHD Population Data Calendar Year 2007

Model Year	Population		VMT		NOX		PM	
	(#)	(%)	(mi/day)	(%)	(t/d)	(%)	(t/d)	(%)
2007	11,257	6.1 %	946,742	8.1 %	3.67	2.6 %	0.10	2.6 %
2002 - 2006	53,112	29 %	4,335,829	37.2 %	35.34	24.8 %	0.89	24.1 %
1994 - 2001	75,111	41 %	4,884,153	41.9 %	71.71	50.3 %	1.56	42.2 %
1991 - 1993	13,038	7.1 %	579,844	5 %	11.46	8 %	0.38	10.3 %
1987 - 1990	16,476	9 %	591,977	5.1 %	12.6	8.8 %	0.45	12.2 %
Pre - 1987	14,202	7.8 %	316,695	2.7 %	7.88	5.5 %	0.32	8.7 %